RECONFIGURABLE TACTILE-ENHANCED DISPLAY INCLUDING "TAP-AND-DROP" COMPUTING SYSTEM FOR VISION IMPAIRED USERS

REFERENCE TO PRIORITY DOCUMENTS

[0001] This Application claims priority under 35 USC §119(e) to U.S. Provisional Application Ser. No. 60/522,008, filed Aug. 2, 2004, entitled RECONFIGURABLE TACTILE-ENHANCED DISPLAY by John C. Chelen and David Bogart Dort, and also to U.S. Provisional Application Ser. No. 522,403, filed Oct. 4, 2004, entitled TACTILE-BASED FINGER-AS-PEN COMPUTING FOR SIGHT IMPAIRED USERS by David Bogart Dort, both of which are hereby incorporated by reference for all purposes.

BACKGROUND

[0002] Advances in material science have allowed materials that function as a coherent whole or on a miniature (but not necessarily nano or micro scale) materials to obtain properties that have been found from unusual applications. For example, electro-heleological (as well as magneto-heleological, which will only be referred to herein as electro) fluid changes its viscosity when an electric current is passed through it. Thus electro-heleological fluid will stiffen when an electric current is passed through it creating a change in viscosity, which is useful for many industrial applications, including automotive, aerospace and other types of industries.

[0003] An electroheleogical fluid has a fast response time of a few milliseconds and can be adjusted in its viscosity in response to a variation in the electric field. Thus, it can be applied in various fields, such as electrically working active suspension systems, valves, brakes, artificial joints and so on.

[0004] Electroheleogical phenomenon is associated with a variation in the properties of a suspension which occurs when an external electric field is applied. The fluid shows the same behavior as the usual Newtonian fluid in the absence of the electric field, but it is solidified in the presence of the electrical field and shows a strong flow resistance. A great variation in viscosity occurring in the electroheleogical fluid is due to a variation in the microstructure of a suspension. The application of the electrical field to a static suspension results in the rearrangement of particles in the suspension by the polarization phenomenon occurring within the particles or on their surface, and forms a fibril structure connecting electrodes to each other. Where a strain is applied to the fibril structure of the particles perpendicular to the direction of electric field, the fibril structure is distorted. Energy consumed by this strain causes an increase in viscosity of the suspension. In this case, yield stress of the suspension is increased as the electric field strength is increased. Meanwhile, if the applied shear stress is higher than the yield stress of the fluid, the liquid portion is more fluid. The electroheleogical fluid responds to the electric field in a very fast time of about 10.sup.-3 seconds, or a microsecond (which in the context of display systems is incredibly slow, see the discussion below after FIG. **22**) and this response is reversible, so that the electroheleogical fluid can be employed as an excellent medium to transfer electrical signals to mechanical devices. Many mechanical devices have been proposed which use the electroheleogical fluid, including clutches, high speed valves, and vibration-controlling active suspension systems.

[0005] Many kinds of dispersion mediums and particles are disclosed as components of the electroheleogical fluid (U.S. Pat. Nos. 3,397,147; 4,483,788; 4,502,973; and 4,668,417). It is generally known that the electroheleogical fluid contains a small amount of water absorbed in particles dispersed therein (less than 10% by weight relative to the particle weight). Thus, by virtue of the ion polarization phenomenon occurring upon the application of the electric field, the electroheleogical fluid exhibits the electroheleogical effect by the formation of a chain structure or by the formation of a water-cross linked structure between the particles.

[0006] The electroheleogical activity of this fluid significantly depends on a variation in the water content of the fluid. If this fluid is free of water, it disadvantageously loses its electroheleogical activity and can not be used at high temperature. The fluid, free of water, also has drawbacks from the engineering viewpoint that it results in high abrasion of a machine and is limited in its working temperature. It was recently reported that suspensions having completely dried inorganic or polymeric particles dispersed therein have also occurred the electroheleogical phenomenon. In these suspensions, the dispersed particles are a semiconductor in their electrical property. Additionally, the polarization phenomenon in the application of the electric field occurs by the migration of charge carriers by virtue of their inherent physical and chemical properties of the particles rather than those occurring due to water. U.S. Pat. No. 5,417,874 to Carlson et al. discloses an electroheleogical fluid using inorganic particles of a crystalline lattice structure in which fluid can be worked at a temperature range of 25 to 150.degree. C. However, the disclosed electroheleogical fluid has a drawback in that the dispersed particles are high in their density and thus are easily settled.

[0007] Representative polymeric particles dispersed in the non-aqueous electroheleogical fluid include polyaniline particles (See, "The Electroheleogical Properties of Polyaniline Suspensions", J. Colloidal and Interface Science, Vol. 126, No. 1, April 1990, pp. 175-188). European Patent Publication A 394,005 discloses an electroheleogical effect of a suspension of 30% by volume polyaniline dispersed in a silicone oil. U.S. Pat. Nos. 5,595,680 and 5,437,806 describe non-aqueous electroheleogical fluids using polyanilines and derivatives thereof polymerized from aniline monomers and a mixture of aniline monomers and various monomers.

[0008] A dispersion medium of the electroheleogical fluid must have an electrically insulating property and may contain a surfactant to improve its stability. An effective dispersion medium generally needs to have a good dispersibility, a low viscosity and electrical conductivity, a high boiling point, a low freezing point, a chemical stability, and a high dielectric strength. U.S. Pat. No. 4,687,589 discloses physical property values required in the dispersion medium.

[0009] Halogenated oil is great in its specific gravity and less in its particle-settling degree, as compared to the conventionally used silicone oil. Also, the halogenated oil may be increased in its electroheleogical activity as compared to the silicone oil, but a precise mechanism for this increase is not known. In the case where additives such as surfactant are